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ABSTRACT

The Student Response System (SRS) is discussed and evaluated. This is an electronic system whereby an instructor receives instant feedback from students by asking questions each with up to five multiple choice answers. The report covers a description of the SRS, a review of the Skidmore College project on computer applications, and a review of the grant from the National Science Foundation, physical setup for the project, common uses of the SRS, uses of the SRS at Skidmore, combined uses of the SRS in class, uses of computer analysis, individualized uses of the response system, extent of usage, evaluation of the response system, a small statistical evaluation, and a summary of evaluation. (MJM)

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STUDY AND EVALUATION OF THE STUDENT RESPONSE SYSTEM IN UNDERGRADUATE INSTRUCTION AT SKIDMORE COLLEGE

Report to the National Science Foundation

by

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STUDY AND EVALUATION OF THE STUDENT RESPONSE SYSTEM IN UNDERGRADUATE INSTRUCTION AT SKIDMORE COLLEGE

Yu-kuang Chu, PhD

I. DESCRIPTION OF THE STUDENT RESPONSE SYSTEM

A Student Response System, known as SRS 1000C, has been developed in recent years by the Research and Development Center of the General Electric Company. It is essentially an electronic system whereby an instructor can get instant feedback from his students by asking questions each with up to five multiple-choice answers. There is an Input Station in front of each student, containing five white numbered buttons corresponding to numbered multiple-choice answers. (See Fig. 1.) The student pushes one of the buttons to indicate his selected answer. If he wants to change his mind, there is a red button to cancel his previous choice, which he can use before he puts in another answer.

Student responses are scanned and reflected immediately in five percentage meters on the instructor's panel mounted on a lectern, showing him what percentage of the class has chosen each option under a given question. (See Fig. 2.) There is a sixth meter to indicate the total percentage of the class that has answered that question. If there is a correct answer, its number may be shown in a "Display Box" in front of the class. The five buttons can also be used as a five-step rating scale to express degrees of agreement, importance, interest, usefulness, etc.

If desired by the instructor, the Response System can be linked up with a teletypewriter, which will record and print out the student responses, identifiable by seat numbers and question numbers, and at the same time will encode the data on a paper tape. The printout is immediately available after class for inspection by the instructor or students. (See Fig. 3.) The tape may be fed into the teletypewriter, when it is used as a terminal on line with a computer. The computer will analyse the data according to a selected program and the results will be printed on the teletypewriter. Such a printed analysis can be obtained in only a few minutes.

II. SKIDMORE PROJECT ON COMPUTER APPLICATIONS AND GRANT FROM THE NATIONAL SCIENCE FOUNDATION

The Student Response System has been installed in recent years at several large universities, where large classes have found the equipment useful. But GE wanted to explore the capability of this equipment in a small institution, and Skidmore College, which is a four-year liberal arts college located at Saratoga Springs, New York, with most classes enrolling 15 to 25 students each, was interested in introducing computer applications into the teaching-learning process in undergraduate instruction. So the two organizations entered into a cooperative research project. The aim of the cooperative project is to try to use the SRS in as many different ways and academic disciplines as possible and to attempt an evaluation of its usefulness in undergraduate instruction.

Skidmore applied to the National Science Foundation for financial assistance (Proposal No. JO 00317) and received in October 1969 a grant of $70,000 (Grant No. GJ-317) for the following budgeted expenses:

Purchased Equipment	$53,000
Rental Equipment & Communications	15,700
Travel	300
Expendible Supplies	1,000
Total	$70,000

Figure 1. Student Station

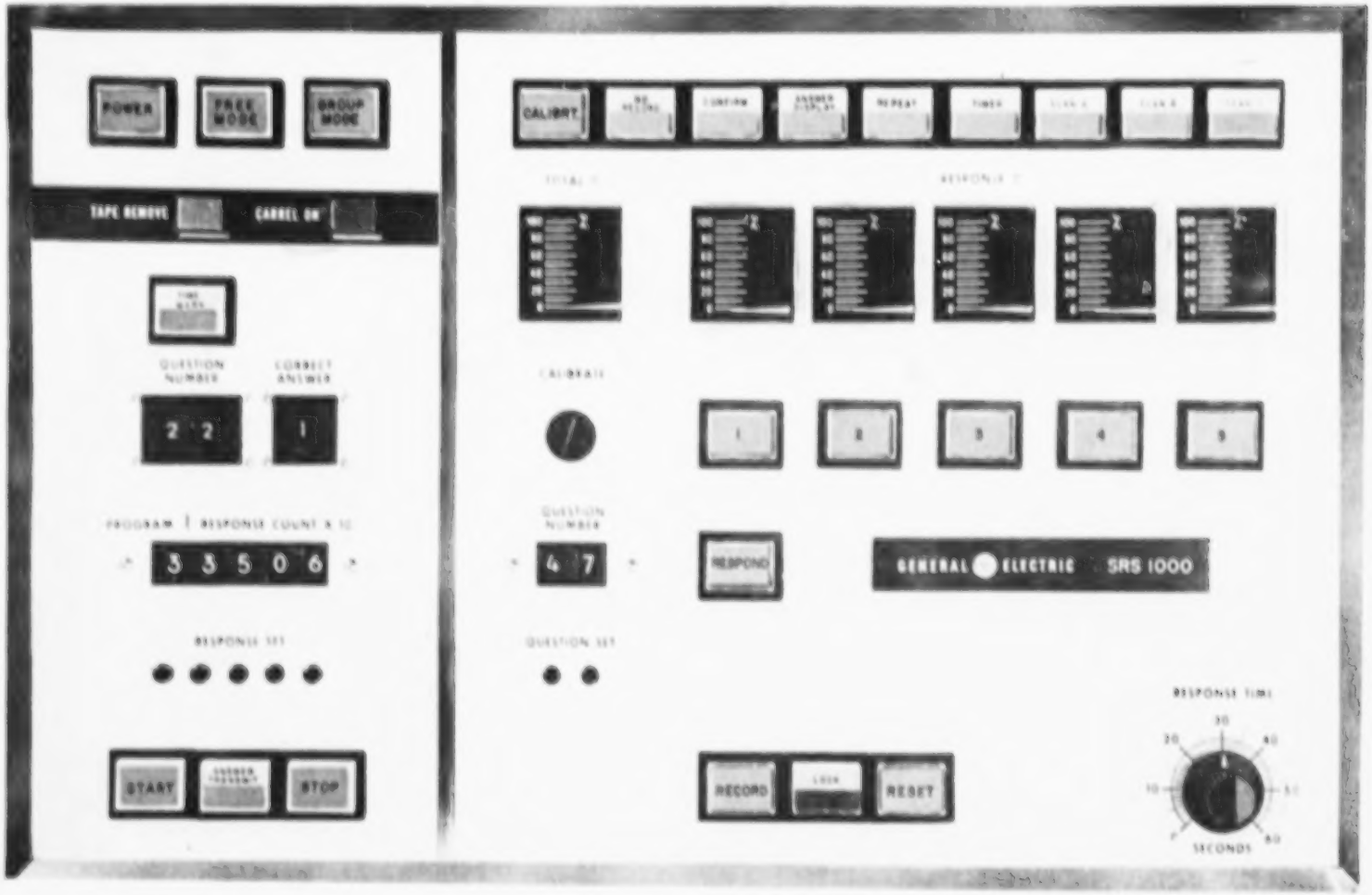

Figure 2. Instructor's Control Panel

Line No.	Ques. No. →	Instr. Ans.? →	Seat #5 →	Seat #10 →	Seat #15 →	Seat #20 →	Seat #25 →	Seat #30 →	Seat #35 →	Seat #40 →
90010		1	0	1	2	0	0	0	0	0
90020		2	0	3	3	0	0	0	0	0
90030		4	0	4	4	0	0	0	0	0
90040		1	4	4	4	0	0	0	0	0
90050		3	3	3	3	0	0	0	0	0
90060		1	2	3	1	0	0	0	0	0
90070		2	3	2	2	0	0	0	0	0
90080		1	3	4	0	0	0	0	0	0
90090		2	2	1	4	0	0	0	0	0

Printout of Responses on a Teletypewriter. Format is the same for all kinds of questions. In this example, nine questions were used, and there were 16 students in the class. Responses are represented by numbers. The first column, after the Line Numbers, consists of Instructor's Answers, if questions have correct answers. Otherwise, instructor's response would be "0." Students' responses are identified by Seat Numbers. Some seats were not occupied. Student at Seat #1 failed to answer the first three questions. Perhaps he was late to class.

Figure 3. Raw Data Printout

The anticipated contribution by Skidmore to the support of the project, including Indirect Costs, was $78,783, but this figure was actually exceeded by about $25,000 due to unexpected increase in construction costs. The purpose of the grant, as designated by the NSF, was "Study and Evaluation of the Student Response System in Undergraduate Education." The period of the grant was originally for two years (October 1969 - October 1971), but due to the late start of the project caused by delay in construction, the termination date was subsequently extended by NSF, at Skidmore's request, to October 1972. However, there was no additional funding for the extended year though the grant was entirely expended during that time.

III. PHYSICAL SETUP FOR THE PROJECT

With the NSF grant, Skidmore purchased the SRS 1000C equipment from the General Electric Company. To install the System, Skidmore constructed a 40-seat classroom and related projection and terminal rooms as part of the facilities of a newly established Computer Applications Center on the top floor of the library building on the New Campus. The classroom is equipped not only with the SRS but also for movie, slide, and overhead projection as well as with a tape recorder. The Research and Development Center of General Electric provided programming and consulting services. Computing time was obtained, free of charge, on a time-sharing basis by arrangements with Griffiss Air Force Base in Rome, New York, which has a GE 645 computer. Our terminals were linked by leased telephone lines with the Rome computer, and one of the terminals can be connected through an interface with the Response System in the classroom. The whole system was in operating condition in May 1970, just as the academic year was drawing to a close. So real use of the facility could not begin in earnest until September. This fact was the justification for the request for extension of the grant period. This means the present evaluation study was based on our use of the System for one and a half academic years.

IV. COMMON USES OF THE STUDENT RESPONSE SYSTEM

From the start we adopted the policy of going beyond some obvious and common uses of the SRS and of trying to foster the more creative aspects of teaching and learning through the use of the System. Two obvious and common uses, and our intuitive judgments thereof, are as follows:

1. The first is to ascertain the level or degree of immediate comprehension by students of the material presented by the instructor. He may ask questions of the true-false or multiple-choice type, in the course of his presentation or at the end. Students' responses will show how successfully he has communicated with them and whether there are points that need clarification. This use of the SRS is important in large classes with scores or hundreds of students, but the need for this is perhaps not so great in small classes, where the instructor is in intimate rapport with his students. Nevertheless, this use is important in courses with a great deal of highly objective content, as in science and mathematics. If the questions go beyond asking the students to recall information and provoke thinking and discussion, then this use of the SRS is important in all academic disciplines and in classes of any size. It tends to encourage a more active learning process than a straight lecture-test technique would.

2. Another obvious use of the SRS is to administer multiple-choice or true-false tests to large numbers of students with minimum labor and maximum speed in scoring and analysis of results. If this is for the purpose of grading students in courses, we are rather critical of this use. In view of the present-day thinking and attitudes of students regarding their own education, we do not want them to feel that here is a mechanical system to manage their learning and to induce in them conformity in thinking as the average objective tests are wont to do. Testing for experimental purposes, with the cooperation of students and not for grading would, of course, be a different matter.

V. USES OF THE STUDENT RESPONSE STYSTEM AT SKIDMORE

Following are some of the actual uses of the SRS made by a number of the Skidmore faculty. The selected examples do not exhaust the "repertoire" of any single instructor or the potentiality of the System, but they aim at a variety in uses. It will be observed that none of the ways used the System for grading students and all of them represented attempts to use the SRS to promote active teaching-learning processes, which departed in varying degrees from the simple pattern of straight lectures followed by tests of retention. Many used the student responses as a point of departure for teaching. This tended to increase students' feeling of relevancy of what was taught to their own interests and needs.

The sample uses are grouped under four categories according to four different ways of using the SRS, for each of which there is a distinctive computer analysis program. These programs except one were furnished by GE.

A. Using the SRS to Teach Understanding, Knowledge, and Skills by Asking Questions Having Correct Answers

1. Sentence variations to teach punctuation and stylistics. In an English class for culturally deprived high school graduates preparing them for college admission, an instructor used the Response System in one period to teach punctuation, specifically the correct uses of the comma and the semicolon. He projected on a screen a series of sentences, each in several variations, involving the use of the two punctuation marks. Students were asked to pick out the correct version in each case. Discussion of these cases constituted instruction. This was an example of inductive teaching of a grammatical rule. Computer analysis of student responses showed how each student did, as well as which questions were difficult or easy, thus providing a guide for subsequent instruction. (See Fig. 4.)

The same technique was used in a class in Freshman Composition to teach stylistics. A number of short paragraphs were shown to the class by overhead projection. In each paragraph, after several sentences of context material, a "punch-line" sentence was shown in four variant forms, all grammatically correct. The students were asked to indicate their preferred form by pressing the appropriate button, and their choices were immediately reflected in the percentage meters on the instructor's panel. They were asked to explain their choices, which resulted in a lively discussion. Strictly speaking, in this case of stylistics there is no correct choice, although the instructor indicated his own preference for one form, or alternative forms, depending on the purposes of the writer.

GENERAL INFORMATION

9 QUESTIONS SCORED
35 STUDENTS PRESENT
CLASS MEAN = 6.71
STANDARD DEVIATION = 2.16
RELIABILITY COEFFICIENT = 0.72

PROBLEM ANALYSIS

PROBLEM NO.	PERCENT CORRECT	CORRECT ANSWER	RESPONSE COUNT 0	1	2	3	4	5	DISC. INDEX
1	5.7	1	2	1	19	9	4	0	.0
2	91.2	3	1	1	4	32	0	0	0.00
3	87.5	4	1	0	1	0	28	0	.50
4	74.2	5	0	1	0	0	26	0	.25
5	94.2	3	0	0	1	33	0	0	.0
6	71.0	1	0	25	1	1	0	0	.75
7	71.0	2	0	0	0	1	0	0	.50
8	45.7	1	0	1	2	7	6	0	.50
9	68.7	2	1	2	22	1	1	0	.25

STUDENT ANALYSIS

RANK ORDER	SEAT NUMBER	SCORE	PCT. CORRECT	T-SCORE
1	6	8	88.87	64.06
2	2	8	77.78	57.83
3	1	8	77.78	57.83
4	10	8	77.78	57.83
5	11	8	77.78	57.83
6	15	8	77.78	57.83
7	25	7	77.78	57.83
8	32	6	66.67	51.80
9	17	6	66.67	51.80
10	24	6	66.67	51.80
11	3	5	55.56	45.77
12	35	5	55.56	45.77
13	20	5	55.56	45.77
14	33	4	44.44	39.87
15	4	3	33.33	33.72
16	5	2	22.22	27.57

Output of Computer Program "ANAL 1" Analyzing Responses to Questions Having Correct Answers. "Discrimination Index" indicates the power of a given question to distinguish between the top quarter and the bottom quarter of the class. The higher the index, the greater the power. The conversion of raw score into "T-score" makes possible comparison of student performance on different tests, if "normal curve" distribution of abilities is assumed.

Figure 4. ANAL 1 OUTPUT

2. Diagnosis of a class or of individual students. A professor in Foundations of Education used the SRS to administer a true-false test in order to ascertain what the students already knew or did not know as regards the unit she was about to teach. This information enabled her to concentrate on teaching those things which the students did not know. It also served to motivate the students as they could see clearly what they needed to learn and thus guided their readings in assigned references.

A professor of English used the SRS to administer a diagnostic test in English grammar consisting of 50 questions of the objective type. The printout on the computer terminal immediately available upon completion of the test as well as the later analysis by the computer showed clearly the strengths and weaknesses of each individual student without tedious analysis performed manually by the instructor. Remedial instruction individually designed for each student could then be given.

3. Other examples under this category of use were: (a) A Chemistry professor used the SRS to test student understanding of a concept and its implications, some of which he did not discuss but expected his students to deduce, if they had correctly understood the concept. (b) A mathematics professor asked students to respond to several questions at the beginning of each period, highlighting the major points of the last lecture and serving as a springboard for the current lecture. (c) A professor of Psychology used the SRS to teach the relation of standard deviation to normal frequency distribution in a variety of statistical operations. (d) A biology instructor conducted near the end of a semester a quick review session during which students responded through the SRS to a long list of objective-type questions covering the major areas of the course, thus revealing to each student his own weaknesses in advance of the real semester examination.

B. Using the SRS to Conduct an Opinion Poll or to Express Preferences

Naturally, under this category of use, questions have no standard answers.

1. Studying contemporary student values and mores. A class of 30 students in a course on Education and Culture answered the questions dealing with present-day student values and mores in a national survey by LIFE Magazine (Vol. 70, No. 1, Jan. 8, 1971, pp. 22-30) and compared their own results with those of a national sample. Since the questions were answered by "Yes" or "No," computer analysis simply gave the percentage of students choosing option #1 (Yes) and that for option #2 (No) under each question. (See Fig. 5.) The results served as a basis for discussing education in relation to culture.

2. Managing discussion in committee meetings. Student organizations also used the SRS. A student committee of 23 members conducted several meetings in the Response System classroom discussing what students wanted to recommend to the faculty in regard to certain all-college requirements, such as a foreign language, Freshman English, and physical education. The chairman presented a question dealing with a specific requirement with four alternative ways of handling it plus a fifth option for a "way not covered by the preceding four," as follows:

(1) Maintenance of the requirement.

(2) Abolition of the requirement.

(3) Reduction of the amount of the requirement.

(4) Exemption from the requirement on demonstration of proficiency.

(5) A solution not covered by the preceding four.

She used the SRS to find out the initial reactions of committee members. Then they discussed the various alternatives, and students voting for the fifth option aired their views. She took soundings again. On the basis of majority position she formulated a proposition

QUESTION NUMBER	RESPONSE COUNT 0	1	2	3	4	5
1	6	13	11	0	0	0
		54.2%	45.8%	0%	0%	0%
2	0	25	5	0	0	0
		83.3%	16.7%	0%	0%	0%
3	0	8	22	0	0	0
		26.7%	73.3%	0%	0%	0%
49	2	4	24	0	0	0
		14.3%	85.7%	0%	0%	0%
50	1	25	4	0	0	0
		86.2%	13.8%	0%	0%	0%

Output of Computer Program "OPINION," Analyzing Responses to Questions Having No Correct Answers. It gives the number of students choosing each option, and its corresponding percentage, under each question. Percentages are calculated in terms of the total number of students responding to a given question. E.g., six students failed to Answer Question #1; this number was ignored in calculating percentages under this question.

Figure 5. "OPINION" Output.

and asked the committee members to express agreement or disagreement with it through the SRS. (For technique, see Category C following.) She repeated this several times, each time refining or qualifying the proposition until she got a consensus or a large affirming majority. She considered the System useful in both recording the process of opinion formation and eliciting discussion in terms of the breakdown of opinion on a particular question. Each member of the committee could anonymously express his thought as well as vocally defend it, if he desired. Thus, every one participated in some way during the meetings.

3. Other examples of this category of use are: (a) A professor of Physical Education in teaching a course on evaluation procedures and research techniques used multiple-choice questions through the SRS to test student selection of research procedures or formulas to be employed, to determine the sequence of steps in research, or to evaluate research literature. (b) A professor of Elementary Education asked students to select one of five alternative techniques for teaching the meanings of certain words in given passages in textbooks. (c) A psychology professor compared the attitudes towards suicide of two groups of students, one of which had had a "bull" session with him on the subject, but the other had not. (d) A lecturer in Asian Studies discussed with his students their reactions to foreign films monitored by the SRS. (e) An instructor in Chinese history explored student background for and present interest in area studies as well as their attitudes toward public issues relative to Asia. (f) A Geology professor asked his students to evaluate an experimental part of his course anonymously at the end of the term by answering a list of questions through the SRS. (g) An orientation program making

explicit the mutual expectations of the instructor and his students in the way of teaching-learning goals, course contents and methods, evaluation of student performance, etc. was developed for use by faculty members at the beginning of a term so as to achieve understanding and rapport between instructor and students.

C. Using the SRS as a Rating Scale to Explore Attitudes and Feelings

1. Using SRS as a rating scale to study attitudes. A visiting lecturer at a Child Psychology Institute, conducted for a group of college teachers of Psychology, explored through the SRS the attitudes of the group towards the behavioral point of view in Psychology. The professor presented orally a list of 19 statements on various implications for child development and education of the point of view in question. He asked members of the group to express their agreement or disagreement with each statement using the five buttons as a five-step scale:

"1" representing "Total disagreement."

"2" representing "Disagreement."

"3" representing "Neutrality."

"4" representing "Agreement."

"5" representing "Total agreement."

The percentage meters on the instructor's panel instantly showed him how the group reacted to a given statement. He announced the percentages to the group, followed by comments by him or by participants. It was interesting to note that his first statement was the most general and comprehensive, and his 19th statement was identical to the first. For some participants, their responses on the 19th indicated a significant shift in attitudes from their responses towards the first statement, apparently caused by their reacting to the intervening ones.

In computer analysis of rating responses, Button #1 is arbitrarily chosen not as a standard but as a reference point in scoring. A students' response is scored in terms of the number of steps it is away from "1." "Four" is the maximum score for any one question. (See Fig. 6.) If Button #3 represents "neutrality," as in the case above, then a score of "2" means "neutrality." The farther up a score is above "2," the stronger the tendency towards "total agreement." On the other hand, the lower down a score is below "2," the stronger the tendency towards "total disagreement."

However, if a scale represents linear progression from zero to maximum (e.g., "1" = "Useless," "2" = "A bit useful;" "3" = "Moderately useful;" "4" = "Quite useful;" and "5" = "Very useful,") then the higher the score, the stronger the tendency towards the upper end of the scale.

GENERAL INFORMATION

19 QUESTIONS SCORED
26 STUDENTS PRESENT
CLASS MEAN = 2.92

PROBLEM ANALYSIS

PROBLEM NUMBER	REFERENCE POINT	RESPONSE COUNT 0	1	2	3	4	TOTAL SCORE	MEAN SCORE
1	1	0	4	1	1	4	10	3.84
2	1	0	9	10	1	1	1	2.69	3.12
3	1	0	0	2	0	14	19	3.84	3.23
4	1	1	7	5	3	6	4	3.85	3.02
5	1	0	13	4	1	0	2	1.4	.54
6	1	0	4	7	5	6	4	3.5	3.96
18	1	0	0	1	4	7	14	3.6	3.31
19	1	0	12	5	5	2	2	2.9	3.12

STUDENT ANALYSIS

TASK ORDER	SEAT NO.	TOTAL SCORE	MEAN SCORE	T-SCORE
1	15	53	2.79	54.29
2	14	49	2.58	51.13
3	25	48	2.53	50.34
3	27	48	2.53	50.34
13	17	38	2.00	52.47
13	18	38	2.00	52.47
23	4	29	1.53	45.39
23	12	29	1.53	45.39
25	24	27	1.42	43.81
26	7	26	1.37	43.02

Output of Computer Program "ANAL 2" Analyzing Responses on a Rating Scale. SCORE = No. of steps away from "1." A response on #3 on the scale is scored as "2" (2 steps from "1"). A response on #5 on the scale is scored as "4," which is the maximum score for any one question. In PROBLEM ANALYSIS, TOTAL SCORE is the sum of the scores of all the students on that problem, and MEAN SCORE is obtained by dividing TOTAL SCORE by the number of students. In STUDENT ANALYSIS, TOTAL SCORE is the sum of the scores on all problems achieved by that student, and MEAN SCORE is obtained by dividing TOTAL SCORE by the number of problems.

Figure 6. ANAL 2 OUTPUT

2. Other examples of this category of use are: (a) A Biology professor generated class discussion of an assigned reading by asking students to express through the SRS their agreement or disagreement with the general point of view of the author as well as with specific statements he made. (b) After using the SRS in the teaching of a class or course, the instructor asked the students to rate on a five-point scale the usefulness of the Response System in that particular class or course. (c) A group of students interested in admission procedures of the College was asked to express the degree of agreement or disagreement with the hypothetical proposition that Skidmore henceforth cease using SAT-Verbal and SAT-Math scores in considering an applicant for admission.

D. Using the SRS to Establish Priorities

1. Studying priorities in value systems of different societies. A professor of Asian studies asked

his students, who happened to be all women, each to give him a list of several factors or values she would look for in selecting a prospective mate. From these lists he made a composite list of 22 factors. The first step was to find the five top values for the class as a whole. The students were asked to examine the list of 22 factors and each to select five factors most important for herself. As each factor was announced by the instructor, each student pressed either Button #5 to indicate it was among her top five values or Button #1 to say it was not, but never used the in-between buttons. From the immediately available printout of raw data, the instructor could readily select the five factors with the most "5's" and the least "1's." The second step was to establish an order of priorities among the top five. Students were asked to assign mentally one of the five buttons to each of the five factors, with no button used more than once and with "5" representing the highest priority and "1" the lowest among the top five. Then, as each factor was announced, students pressed the appropriate button. (For computer calculation of weighted scores, see Fig. 7.) The results were: first, love; second, intelligence and education; third, compatibility; fourth, integrity; and fifth, sense of humor.

	QUESTION NUMBER	0	RESPONSE COUNT 1	2	3	4	5	WEIGHTED SCORE	MEAN SCORE
Western Marriage:									
Compatibility	1	0	1	5	5	6	1	55	3.06
Humor	2	0	6	5	2	2	0	33	1.83
Integrity	3	0	3	7	2	5	1	48	2.67
Intell. + Educ.	4	0	1	0	7	6	4	60	3.33
Love	5	0	2	0	0	2	13	76	4.22
Chinese Marriage:									
Loyalty	6	0	2	3	4	5	1	50	2.78
Health & Fertil.	7	0	0	2	5	7	5	65	3.61
Humility & Obed.	8	0	6	2	2	2	6	54	3.00
Love of Children	9	0	3	0	3	3	2	48	2.44
Comp. Fam. Bkgrd.	10	0	5	0	1	6	6	58	3.22

Output of Computer Program "TXSCALE," Establishing Priorities Among Items. "Weighted Score" is obtained by multiplying each button value by the number of persons choosing that button and then summing up the products. E.g., for "Compatibility" it is (0x0) + (1x1) + (5x2) + (5x3) + (6x4) + (1x5) = 55. "Mean Score" is obtained by dividing 55 by the number of students participating (18). Since Button #5 was used to represent the highest priority, the larger Mean Score, the higher the priority.

Figure 7. TXSCALE OUTPUT

Next he reminded the class of its earlier study of the traditional family system in China, under which marriage was not a personal but a family affair, and as such, it was arranged by parents with the primary objective of producing offspring. The class was asked to suggest a list of values Chinese parents would look for in a prospective daughter-in-law. Again, through the use of SRS, the top five values and their priorities were ascertained. They were: first, health and fertility; second, comparable family background; third, humility and obedience to parents-in-law; fourth, loyalty to family; and fifth, love of children. It became obvious to the class that traditional Chinese and contemporary Western marriages had very different value systems. None of the top five Chinese values was found in the composite list of 22 Western values.

It was pointed out to the class that marriage was merely a single illustration of a general principle very important in the study of foreign cultures and societies. What is this principle? Class discussion concluded with this generalization: each society or culture has its own value system appropriate for each of its institutions; you cannot impose the value system of one society upon another unless you change the latter society. The lesson was a good example of having students perform a demonstration of an abstract principle. The SRS with its capability of instant feedback made it possible to compress the whole teaching-learning process into a 50-minute period, with no tedious calculations on the part of the instructor or students.

2. Other examples of this category of use were: (a) In a class in Dance Appreciation, students were shown a film of two Chinese, two Korean, and one Japanese dance and asked to arrange the five dances in descending order of personal likes and explain why. (b) A group of college admissions officers arranged in order of priorities five specific factors governing the admission of applicants.

VI. COMBINED USES OF THE STUDENT RESPONSE SYSTEM IN CLASS

To recapitulate, the above illustrative uses of the SRS are classified into four categories according to the nature of the questions used:

A. Using the SRS to teach understanding, knowledge, and skills by asking questions having correct answers.

B. Using the SRS to conduct an opinion poll or to express preferences by asking questions having no standard answers.

C. Using the SRS as a rating scale to explore attitudes and feelings.

D. Using the SRS to establish priorities.

In any one instructional period, the instructor may use any combination of categories to suit his teaching objective. However, if he wants computer analysis of student responses to be done after class, then the records of responses to different kinds of questions must be separated before transmission to the computer, because each type of question calls for a different computer analysis program. (See Figs. 4 through 7.)

VII. USES OF COMPUTER ANALYSES

For many faculty users of the SRS, the information gained from the percentage meters on the instructor's panel was sufficient for feedback purposes. The instructor would not know which student responded in what way, but he could readily see what percentage

of the class reacted in what way. This is the easiest and the commonest way of using the Response System. Since this information is instantaneously available, it tends to affect the teaching-learning process immediately. This use is important both in teaching basic knowledge and in directing discussion.

Some instructors wanted, in addition to information from the percentage meters, a recording of student responses in the form of a printout on the teletypewriter available almost immediately. It takes only five seconds to record and print out the responses of 40 students as well as that of the instructor to one question. This information is more exact than the readings of percentage meters since one can tell from the printout how the student at each occupied seat responded. (See Fig. 3.) If the printout is posted after class with a list of the questions used and if a student remembers where he sat, he can compare his own responses with those of the instructor and those of his fellow students.

Other instructors definitely wanted computer analysis and regarded the step of recording as incidental to the step of creating a paper tape with the responses encoded on it, by means of which the data could be transmitted through a telephone wire to a distant computer for analysis according to the program selected. Since we had access to the computer in Rome, New York, only in the afternoon of a weekday, the analysis could be made available to the instructor on the day of his class or in the following morning, depending on the hour of his class.

Since the wishes of the faculty users varied in the above way, we found it useful to organize our written instructions on "How to Operate the Response System" into three parts: Part I, How to Operate the Percentage Meters; Part II, How to Obtain a Recording; and Part III, What to Do to get a Computer Analysis. Part I was included in Part II, and Parts I and II were included in Part III. Each user could pursue the instructions only as far as his interest went. As a user gained confidence in using the System in a simple way, he could move on to a more complex way. This avoided the danger of "frightening" or confusing a new user with a lot of complicated instructions given in one shot. In briefing faculty members, we had to emphasize frequently how easy it was to operate the System.

As to computer analysis, there were four programs to take care of the four major uses of the Response System as outlined in the preceding two sections and a fifth one for changing the format of data. There were other programs to treat data collected by the System in the Free Mode. (See section following.) All programs, except one, for analysis of SRS data were created and furnished to us by General Electric. The exception, called "OPINION," was created by our own staff. Following are some common uses of various programs:

1. ANAL 1: This program scored student responses according to a standard key supplied by the instructor or correct answers entered by him through the instructor's panel. (See Fig. 4.) Its greatest usefulness was in connection with giving tests or quizzes, in which every question had one and only one correct answer, whether for the purpose of generating discussion or review or for grading students. It yielded statistical information on the performance of the class as a whole as well as that of individual students. A feature of the program not illustrated in Fig. 4 was the capability to make individual diagnosis by instructing the computer to conduct as many "passes" over the data as there were sub-areas of the test, yielding for each student a sub-score for each area as well as a total score for the whole test.

ANAL 1 was also found very useful for item analysis of a test. The section of the output called "Problem Analysis" showed what percentage of the class had answered each question correctly, and from the "Response Count" for each question the instructor could see not only the number of students getting the correct answer but also the most "popular" errors. Such item analysis enabled the instructor to improve his test and his technique of testing.

2. OPINION: This program was very useful in analyzing student opinions on questions and issues having no standard answers. It simply gave the number and the percentage of students choosing each option under each question and left it to the instructor and students to interpret the significance. (See Fig. 5.) Though the Response Count in ANAL 1 gave the number of students choosing each option under each question and so could also be used to study the distribution of student opinions, many instructors balked at the use of ANAL 1 for this purpose, because the program presumed one correct answer for each question. So OPINION was created to tabulate opinions from a neutral or open-minded point of view. It also had the advantage of giving both numbers and percentages of students under each option.

A new use of this program has been planned. The author of a new text in General Psychology will let a class use the book in manuscript form. Every major paragraph will be numbered. At the beginning of each class period, the students will be asked to spend a few minutes evaluating each numbered paragraph in the chapter assigned for that class period by answering a question such as the following:

"How would you characterize this paragraph?

"(1) Meaning not clear

"(2) A concrete example would help

"(3) Language too involved or difficult

"(4) Content uninteresting or not relevant

"(5) Satisfactory"

On the basis of student comments the author will revise the manuscript.

OPINION was tailored for data on opinions entered through the SRS in a class situation. For such data

entered through the Response System in the Free Mode (see next section), there was a program, called "NLSCORE," which accomplished the same purpose.

3. ANAL 2. This program analyzed student responses when the five buttons of the Input Station were used as a five-step scale for rating purposes. (See Fig. 6.) It was found very useful in all sorts of student evaluations of instructional materials, courses, and instructors. It was also frequently used to stimulate class discussion by allowing students to express candidly their agreement or disagreement with what was said by the instructor or the textbook, etc. The SRS encouraged a 100% student participation.

4. TXSCALE: This program yielded weighted scores for various items to be arranged in order of priority in the judgment of a class. (See Fig. 7.) Since priorities are usually subjective, this was another way of studying student opinions.

5. LSTOMAN: This program was devised to surmount the limitation of ANAL 1 and ANAL 2 to responses from a single class or section of students because of the identification of students by seat numbers. When students from two or more sections of the same course responded to the same questions we used LSTOMAN to combine the data into manual form, inserting section numbers to differentiate students who occupied the same seats but in different sections. The combined data could then be processed by one of the ANAL programs.

In summary, the main point to be emphasized in discussing the use of computer analyses is that analysis by computer saved the instructor a lot of time and from a great deal of drudgery; and hence, tended to encourage him to obtain such analyses more frequently than otherwise, thus hopefully resulting in improvement of instruction.

VIII. INDIVIDUALIZED USES OF THE RESPONSE SYSTEM

The above ways of using the SRS illustrate its operation in the Group Mode, i.e., in class instruction. The System can also operate in the Free Mode, which facilitates individualized instruction and independent study. Students working with individualized instructional material, whether "programmed" or otherwise, may come to the Response System classroom at any time and enter their responses to questions through the SRS. Different students working on material in different courses may work at the same time in the classroom, each at his own pace. Their responses will be continuously scanned and recorded on a teletypewriter in mixed-up order. ID numbers for students and courses will necessarily be used so that the computer may sort out the student responses by courses, by students in each course, and by questions under each student's ID. After sorting, the computer will score the responses and analyze the results in a manner specified by the analysis program selected. To test this capability of the SRS, a few examinations in Biology, Psychology, etc. were administered through the System operating in the Free Mode. At first, we experienced great difficulty in having Free Mode data processed by the computer we regularly used, but when we shifted to the computer of the GE Research and Development Center, for the processing of such data, the results were very satisfactory.

During the spring semester of 1970-71 the Department of English ran an experiment to compare the effectiveness of three different approaches to the teaching of Freshman Composition. It involved 11 sections of this course, with a total enrolment of 191 students. The results of the pre-test and post-test were processed by the combined use of SRS and the computer.

The SRS is also a convenience to students or faculty doing independent research projects involving quantitative studies. For example, questionnaire returns can be entered through the SRS, provided there are no more than five options under each question and it is understood that any open-ended questions with written-in answers will have to be scored by hand. There is a computer analysis program which will give, on a printout, the number of respondents choosing each option under each question and its corresponding percentage in terms of the total number of people answering that question. This particular analysis program called "NLSCORE," can handle questionnaires with up to 99 questions and up to 199 respondents.

Several faculty committee questionnaires concerning curriculum questions, one involving as many as 600 returns, were processed in the above way. This saved the committees a lot of tedious work otherwise involved in manual calculation. Again, more than a dozen questionniare studies conducted as individual projects by students in Business and Nursing were processed, with the students learning the techniques of processing.

There are, of course, other forms of quantitative studies compatible with treatment by the SRS. The point to be emphasized here is that the researcher, whether student or faculty, can be spared from time-consuming and tedious tabulations and calculations and so focus his main attention on analyzing his research problem, formulating his design, collecting his data, thinking through the procedure of treating his data, and when the results of analysis are delivered by the computer, interpreting the results and drawing his conclusions--precisely those steps in his project that are most educational and least mechanical. The time required for completion of work is speeded up immeasurably by the computer.

Plans have been laid to encourage faculty members to produce material for individualized instruction either in connection with their courses or as independent study projects. A group of ten professors from

as many academic disciplines has agreed to author instructional material, accompanied by appropriate media, each from his own disciplinary point of view but all focused on a common theme. Students will be encouraged to achieve some degree of integration based on their exposure to multidisciplinary materials. The Response System will probably be of use in monitoring student responses as feedback information to the student to help him improve his learning and to the faculty writers to enable them to improve their instructional materials. But all this is in the future.

IX. EXTENT OF USAGE

Just how much use did the Student Response System get and in what kinds of courses? Courses were scheduled to meet in the SRS classroom at the request of the instructors concerned. In order to invite faculty requests, general announcements were made to the entire faculty, at least once a semester, urging them to inspect the facility and decide for themselves whether they could usefully employ it in their courses. Surprisingly, such general announcements brought forth little interest. This fact seemed a very interesting commentary on the present general feeling among liberal arts college teachers towards machines and technology.

Accordingly, a second approach was employed. "Hopeful prospects" in the faculty were individually invited to come for a personal briefing in regard to the operation of the System and its potential uses in undergraduate teaching. Each decided for himself whether he would like to try it. In the one and a half years the SRS has been operating, the number of faculty members thus briefed exceeded 70, which amounted to nearly 50% of the whole faculty. Recently, two academic departments requested briefings and demonstrations for their departmental staff. Such leadership tends to encourage faculty use.

As a result of these briefings, 29 different faculty members (about 40% of those briefed) each decided to and did hold one of his classes in the SRS classroom. They taught in this room a total of 35 different courses taught to 45 different classes, distributed as follows:

	Courses	Classes
Mathematics, Biology, Chemistry, Geology	11	16
Psychology	5	6
Economics, Government, Sociology, History	5	5
English, Asian Studies, Dance, Art	8	11
Business, Elementary Education, Physical Educ.	6	7
TOTAL	35	45

The average enrolment in these 45 classes is over 15 students each. This would mean no less than 675 students, representing about 37% of the total student body, have participated in the use of the SRS in the last one and a half academic years.

The extent of use among these 45 classes varied widely, ranging from several class periods through a few weeks to steady use throughout the semester. Another way to indicate the amount of use is that during the first academic year the average number of class periods per week, in which classes were conducted in the SRS classroom, was 10, averaging two classes per week day. During the fall semester and winter term of the second year, the average increased to over 15 class periods per week or 3 per week day, representing a 50% increase in use.

Of the 29 faculty users of the SRS, thirteen were "steady" users in the sense that all meetings of their classes took place in the special classroom throughout the duration of the course. The other sixteen were occasional or short-term users. Of the total number of faculty users (29), fourteen were "repeaters" in the sense that, after their first experience with the SRS, they either taught another course using it or the same course to a different class.

Some of the "non-repeaters" first tried out the System in the fall of the second year, and at the time of the writing of this report, they had not yet had an opportunity to repeat. A few had the opportunity but did not choose to repeat.

When all the data on use are considered, we cannot say that the SRS took to instant popularity. Yet the GE representative cooperating with Skidmore in the project told us that we were doing "fantastically" well, considering the size of our institution as well as the fact that we relied chiefly on voluntary efforts of faculty members in developing instructional material for SRS teaching.*

The reasons for a relatively small start are: (1) college faculty anywhere is usually cautious in adopting new changes in curriculum and methods; (2) many instructors are more subject-matter-centered than student-centered in their approach to the problem of college teaching; (3) some instructors are far more concerned with the highly sophisticated outcomes of humanistic learning which the Response System cannot bring out but require the writing of essays, or constructed answers to questions, or other complex modes of expression; and (4) Skidmore is in transition from its old campus to a gradually built-up new campus. During the period under review about two-thirds of its classes were held on the New Campus, while the remainder was still conducted on

*For a more detailed discussion of this point, see Question 8 under "X. Evaluation of the Response System."

the old with a class schedule half an hour behind that of the New Campus in order to permit students to commute between the two locations. As a consequence, classes scheduled for the old campus could not have short-term use of the SRS classroom on the New Campus. (5) The capacity of this special classroom being 40 seats precluded very large classes from using the classroom, even if the instructors had so desired.[5]

X. EVALUATION OF THE RESPONSE SYSTEM

In our original application to the National Science Foundation, it was stated in reference to evaluation: "Evaluation should aim primarily at finding out how many different ways the System can be used to promote 'creative' teaching, in what academic disciplines, and for what educational objectives. ... Evaluations should be specific and relevant to each way it (the System) is used. ...the instructor and his students should rate the System to indicate the extent to which the facility has been helpful in achieving their educational objectives... However, it should be clearly understood that the evaluation... will be mainly qualitative. Statistics will receive a secondary emphasis. ..."

In accord with the above statement, our evaluation will be qualitative and analytical rather than statistical. Three sources of information will serve as the basis for evaluation: (a) data on usage; (b) faculty and student ratings; and (c) opinions of faculty users obtained by individual interviews and in group discussion. The greatest importance is attached to the third source, for there we try to go behind and beyond numerical figures and to interpret our total experience with the Response System. We shall organize our observations around certain questions, frequently raised by visitors, and around the evaluative remarks made by our faculty users.

1. Is the SRS Better Fitted for the Teaching of Some Academic Disciplines Than Others?

Our data on usage showed that the SRS was used in 35 different courses belonging to 15 different academic disciplines representing the humanities, mathematics and sciences, social sciences, and professional fields. The question seems to imply that the Response System permitting student response only to objective-type questions is perhaps better suited to the teaching of the so-called highly objective disciplines such as mathematics and the sciences. But this view overlooks the possibility of using the System to generate class discussion of opinion-issues in the less exact disciplines. Also, the nature of any academic discipline and the nature of the teaching-learning process are both so complex that this dichotomy into "objective" and "subjective" disciplines is false. Every discipline has some objective content and some subjective elements. It is our considered opinion that theoretically any instructor in any discipline, possibly with the exception of courses primarily concerned with the development of performance skills, could find some use for the SRS in certain aspects of his teaching, if he chose to do so. Faculty users are among those who are aware of the importance of the role of student responses in the teaching-learning process. So the extent of use varied with the instructor rather than with the discipline.

2. Is the SRS Useful Primarily for the Purpose of Checking Student Understanding of Lectures and Administering Objective Examinations?

As detailed in the section on "Uses of the Student Response System at Skidmore" above, our faculty users have emphasized a variety of ways of using the System to encourage a more active participation in the learning process on the part of the students and a greater adaptation of the teaching process to student interests and needs on the part of the instructor. The uses departed in varying degrees from the usual lecture-test pattern of instruction.

3. In the Opinion of the Faculty Users and the Students in Their Classes, was the Response System Useful for the Purposes They Had in Mind?

We requested every instructor to ask his students, at the end of a period of use, to answer anonymously the following question through the SRS and that he himself also answered it:

> "How useful has the Response System been to the teaching-learning process as conducted in this classroom in this course? Rate its usefulness according to the following scale:
>
> | 1 | 2 | 3 | 4 | 5 |
> |---|---|---|---|---|
> | Useless | A bit useful | Moderately useful | Quite useful | Very useful" |

Our records are not complete since some instructors did not have time or did not choose to participate in the evaluation. Nevertheless, ratings were obtained from over 64% of the classes. We shall resist the temptation to give an average numerical figure as a statistically precise index of usefulness. Since the purpose for which the System was used, the duration of time in its use, and the number of students involved differed so widely that any average numerical index would be as meaningful as adding apples, oranges, and grapes together and taking an average of them. For what they are worth, we may summarize faculty and student ratings of the SRS for their own purposes as follows:

(a) Faculty ratings turned in range from "2" (A bit useful) to "5" (Very useful), with the majority for "3" (Moderately useful), and 40% for "4" (Quite useful) and "5" combined. A very few faculty users

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[5] Very small classes with less than 10 students each would present no problem as the System could be specially calibrated to take care of small numbers.

known to be critical of the SRS did not turn in ratings for themselves or their students. Had they done so, "1" (Useless) might have been their rating.

(b) As for student ratings, individual ratings ranged from "1" to "5," with the great majority for "3" (Moderately useful). Average student rating was computed for each reporting class. These class averages ranged from "2.1" to "4.7" with the median average rating at "3.3."

(c) In two-thirds of the classes with ratings, the instructors' ratings were somewhat higher than the students' average ratings. In only one class was the instructor's rating the same as the average student rating for that class.

4. In Teaching, What Can Be Done Through the SRS That Cannot be Achieved Without It?

The Response System is uniquely useful:

(a) when anonymity of student response is essential. For example, in collecting information regarding drug use or sex practice among students, the instructor can assure them of anonymity by using only the percentage meters on the instructor's panel and by not recording. Seats are far enough apart and the buttons in the Input Station are close enough that even neighbors cannot easily observe how a student is responding. If he shields the Station with one hand while responding, he can be absolutely sure of privacy. If the instructor desires recording and subsequent computer analysis of data, then he should allow students to sit anywhere they like and promise not to take any special notice of who sits where. This use of the SRS is better than asking for written reports without a signature, because handwriting can sometimes be recognized. Anonymity also encourages students to express freely views that are apt to be unpopular with their classmates or unfavorable to the instructor;

(b) when 100% student participation in discussion is desired. Some feel that the use of the SRS, while justifiable by the instant feedback not otherwise available in a very large class, is really unnecessary in a small one. It is true that if an instructor maintains good rapport with a small class, there can be a free flow of dialogue between them. Yet, in such a situation very often a few bright or aggressive students tend to monopolize the dialogue with the instructor, the rest of the class just sitting back as silent spectators. With the use of the SRS, every student has to be active to the extent of making a decision on the question raised. After the responses are collected and noted, the instructor may indeed throw open the question for free discussion. Having committed themselves to a certain decision, even the formerly "silent" students would be more inclined to speak up for their positions. Hence, class discussion will be more widespread and the learning process will be more active for all students;

(c) When speedy recording of responses and quick computer analysis are desired. Needless to say, this use saves the instructor from a lot of tedious work and therefore will probably encourage him to take more frequent soundings of student responses.

5. Doesn't the Operation of the Response System Tend to "Intervene" Between the Instructor and His Students?

After asking a question, the instructor has to push two or three buttons and the students have to press one before he can talk about their responses. This intervention is disliked by many students and is distracting to the instructor. His train of thought is interrupted by his operation of the machine. This negative feeling is so strong in the case of a few faculty users that they would not use the System again. There is no good solution to this problem. Each faculty user has to decide for himself the question of trading off this undesirable feature for the advantages of the System.

Recently, two faculty users who didn't care to handle machinery had one or two students in their classes trained in the operation of the SRS. At the beginning of each class period, a student would make ready the System. The instructor might on the spur of the moment use the SRS, and the student would operate it for him or the instructor might never use it in that period. It does not hurt the equipment to be in readiness for any length of time. This solution tended to reduce the feeling of distraction.

6. Are there any Inherent Weaknesses in the Response System?

One weakness is that it cannot accept a constructed answer to an open-ended question. Nothing can be done to overcome this. Another limitation is that the number of options under any question cannot exceed five, though it may be less than five, as in a true-false question. A partial solution is to use the fifth option of "Other alternatives." When an instructor sees a significant percentage of students choose the fifth option, he should ask students to air their own ideas. Another solution is to repeat a question, each time having up to five choices. Students who find their answers under the first appearance of the question will ignore its second appearance, or vice versa.

7. Shouldn't Students Have the Educational Experience of Asking Questions and Discovering Many Different Ways of Answering a Question Instead of Having Questions and Multiple-Choice Answers Provided by the Teacher All the Time?

In the experience of some instructors, the multiple-choice answers under a question often sharpened the student perception of the question, and in the ensuing discussion the students frequently gave more

diverse responses than when a question was asked in the traditional way.

However, certainly the instructor should not be the one to ask questions and provide alternative answers all the time. In a free-wheeling discussion, the questions as well as the options under each question may indeed be suggested by the students themselves. They may be written on the blackboard, obviating previous preparation, and then be responded to by the students through the SRS. For example, in a Dance Appreciation class, after seeing two films on Asian dances students were asked to suggest important characteristics of dances in Asia insofar as they were illustrated in the films. The instructor listed their suggestions on the blackboard and then asked the students each to indicate through the SRS which characteristics were within the most important five in his own opinion, uninfluenced by others in the class. The results stimulated a lively discussion, in which the instructor helped the students distinguish the trivial from the essential.

8. Doesn't Pre-Programming of Questions Take A Lot of Time?

Yes, but hopefully, some of the material developed may be of use again when the course is taught next time. The more creative uses of the Response System do require much more of the instructor in time and effort--defining teaching goals, planning of teaching procedures, pre-programming of questions, preparing media, etc. While preplanning tends, in itself, to improve instruction, quite apart from the use of any physical facility, many faculty members feel under pressure of time, that they cannot afford the extra time and effort involved. Ultimately, the question boils down to one of priorities in the use of instructor time. What does the instructor aim to accomplish in teaching? Does the use of SRS to monitor promptly student responses tend to help him realize his goal? Is it worth the extra time and effort involved?

One way to solve this difficult problem is to get expert college teachers to develop software involving the use of SRS in various disciplines. Just as the use of computers in undergraduate instruction did not get very far until software was created in various subjects of the curriculum, the same is true of the use of the Response System. Granted that college teachers are usually very reluctant to adopt whole courses worked out by others, it does not preclude the possibility of producing instructional materials in the form of a large number of small modular units on specific topics commonly found in a course for undergraduates, and thus allowing the instructor to choose whatever units he likes to be incorporated into his own course. A good example of this is the very large number of audio-tutorial units in Biology developed and published by the Burgess Publishing Company, except that these units are intended for individual study whereas we are talking about units for class instruction through the SRS.

An instructor in Physical Education at Skidmore plans to write a unit on First Aid to be taught entirely through the Response System in a workshop. She thinks that teaching First Aid in the conventional way may be a bit boring, but teaching it through the SRS will point up areas that need discussion and will result in more efficient learning in less time. While she is willing to make this extra effort on a voluntary basis, to get a large number of teachers to develop software in various disciplines funds are needed to make possible the giving of "released time" to them or to compensate them for the use of their free time in the summer. Any rapid expansion of the use of SRS would have to await this development.

Administrators must not think that once the equipment is bought, use of it in teaching will follow. Resources are needed for continuous faculty development, if continuous improvement of instruction is the goal. One of the most important lessons we have learned from our project is that we did not plan adequately for faculty development. While we were highly gratified by so many faculty members making entirely voluntary efforts in developing units for SRS teaching, the use of the System could have been much wider, had there been a systematic plan for providing faculty incentives.

9. Doesn't Pre-Programming Result in Inflexibility in Teaching Procedure and Create in the Student A Feeling of Being "Restricted" by the Instructor's Material?

It doesn't have to. The instructor should feel free to depart from a prepared list of questions and let the class discussion go in whatever direction that seems desirable. The unused questions may be used some other time. Or, pre-program only one or two questions as a starter and let the next question grow out of the discussion of the preceding one, thus resulting in an open-ended teaching-learning process.

Sometimes it is wise to provide an opportunity for students to "let off steam" by having such options as "Cop out," "A stupid question," "I have a brilliant answer," etc. Oral discussion after entering responses through the SRS will, among other functions, satisfy students who feel the need for vocal response.

10. Does the Use of the Response System Always Involve Media Preparation?

The instructional material to which students are to respond may be presented by the projection of films or slides, or transparencies on an overhead projector, by playing tapes, or by distribution of mimeographed material, or by staging an activity in process such as a demonstration, a debate, etc. But none of these things is required. A simple question may be presented orally in class or written on the board. Whether an instructor is to go in for audio-visual or other technological aids is entirely up to him.

11. Do Students Feel at Ease in Using the Response System?

We have not studied the problem, but some students have remarked on their feeling of "too much competitiveness." Such feeling may arise in some students, perhaps because they can see their own success or failure in a much more clearly defined way than in vague self-estimates without the use of the SRS. Is this good or bad for learning? Any feeling of competitiveness may be lessened by providing strict anonymity and by not using the SRS for grading purposes.

An instructor pointed out that long-term student users of the Response System might be different in their feelings from occasional users. He sensed that some students were a little uneasy in using the System at the beginning of the semester, but became perfectly at ease at the end of the term. This observation was in accord with a study made by Beth Sulzer at Southern Illinois University, who at the end of a semester of Educational Psychology asked her class of 322 students to answer the question, "How do you like the student response system?" on a five-point scale from "Favorable" to "Unfavorable." Over 50% of the class responded with "1" or "2."*

12. Is there Any Special Seating Arrangement in a Response System Classroom?

The seats in our classroom are arranged in five rows, of eight each, facing the instructor. The Instructor's panel is mounted on a fairly large lectern. We chose this arrangement because it would accommodate the greatest number of seats within a limited space. Some of our faculty users have criticized this seating arrangement as being too conventional and the lectern as too formal. In these days of informality irregularity and casualness are preferred.†

13. What is the Cost of a Student Response System

Naturally, it will vary with the number of seats involved, among other factors. It would not be useful to mention the price we paid for our system, for the equipment was specially manufactured for Skidmore, not a product of assembly line production, and the price is several years old. Suffice it to say that the magnitude of the cost was on approximately the same order as that of an electronic language laboratory having the same number of seats.

The GE Student Response System 1000C is fairly rugged, and service calls have been infrequent.

14. Is the Use of the Computer in Connection with the SRS an Economical One?

In the use of the SRS, students at no time come into direct contact with the computer. The System collects and records student responses, and when these are fed through a terminal into a computer, the latter will analyze the data according to the analysis program selected. Such a program may yield individual analysis as well as group analysis. The computing involves only one terminal on line with a remote computer in a time-sharing system. As compared with CAI (Computer Assisted Instruction), which requires at any one time a separate terminal and a separate port into the computer for every student, the SRS use of the computer is far more economical. Of course, it does not have the advantage of "immediate turn-about" that CAI has. The mode of computer use in connection with the SRS may be called, "Computer Analyzed Instruction" or "CAnI."

XI. A SMALL STATISTICAL EVALUATION

Despite our de-emphasis of statistical evaluation for our purposes, we are going to present a small study of this nature in a specific instance with no attempt at broad generalization. Two sections of a course in General Psychology were taught by the same instructor, studied the same textbook and substantially the same subject matter, and at the end of the semester took the same identical final examination. This examination was of the multiple-choice type. One section was taught in the fall of 1970 in a conventional classroom, while the other was taught in the fall of 1971 using regularly the Response System throughout the semester. The idea of comparing these two sections was more or less an after-thought. So there was no preplanning to make the two sections equal in all essential respects. Registrations for the sections were uncontrolled. Students, as well as the instructor, were not aware of the comparison. The instructor was enthusiastic about the use of the SRS, and most of the students who had such use assigned a high rating to its usefulness.

We used SAT-Verbal and SAT-Math scores, English Composition score, "Converted Rank" in high school, and Grade Point Average at Skidmore

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*Beth Sulzer, Teaching-Educational Psychology with the Aid of a Computerized Student Response System. 1968, P. 6.

†Conceivably, students could sit on the floor, each carrying an Input Station box with a long wire connecting it with the scanning machine in the rear projection room, and the instructor's panel could be mounted on the arm of a sofa chair or coffee table. Let your imagination go! But whatever arrangements you choose, make sure that it will be easy to insure privacy of response. If there are rising tiers of seats, students on a higher level should not be able to see how a student on a lower tier responds. Similarly, the instructor's panel should be so placed that students cannot easily see which button the instructor pushes when he puts in a correct response to a question. All of this is not, strictly speaking, pertinent to an evaluation of the Response System, but colleges contemplating its installation may want to take notice of our errors on the side of formality and conventionality.

as measures of scholastic aptitude and academic performance to show the extent to which the two sections were equal. Then we compared the Final Examination Scores in General Psychology (not semester grades in that course) of the two sections in order to discover if there was any significant difference between them.

The following table summarizes the data:

TABLE 1

Showing the Characteristics of the Students in the Conventional Section and the SRS Section and Their Final Examination Scores in General Psychology

Measures	Conventional Section	SRS Section	Difference: SRS over or under Conv'l
No. of Students*			
Freshman	22 (54%)	7 (20%)	-15 (-34%)
Sophomore	12 (29%)	19 (54%)	+7 (+25%)
Junior	7 (17%)	9 (26%)	+2 (+9%)
TOTAL	41	35	-6
SAT-Verbal Scores			
Mean	573	558	-15
S. D.	63	71	+8
SAT-Math Scores			
Mean	538	542	+4
S. D.	68	74	+6
Engl. Comp. Scores			
Mean	586	584	-2
S. D.	70	73	+3
Converted Rank in H. S.**			
Mean	60	59	-1
S. D.	8	7	-1
Grade-Point-Averages at Skidmore***			
Mean	2.76	3.03	+.27
S. D.	.58	.50	-.08
Psy. Final Exam Scores			
Mean	76.4	80.4	+4.2
S. D.	9	10	+1

*10 students from the conventional section and 5 students from the SRS section were excluded from the comparison for lack of complete data. Those in the comparison were all females.

**Conversion of Rank in High School into a two-digit figure, taking class size into consideration, followed a formula developed by Validity Study Service of the College Entrance Examination Board.

***Grade-Point Average was not cumulative but only for the semester in which General Psychology was taken.

It will be noted that the two sections were not too dissimilar except in two respects. One was a less than 3% difference in SAT-Verbal scores in favor of the Conventional Section. The other was the fact that whereas 54% of the Conventional Section consisted of freshman students, in the SRS Section sophomores made up 54% of the class. An additional year of growth and general maturity might be an important factor.

The differences between the means of the two sections in Psychology Final Examination Scores was 4.2 in favor of the SRS Section. In all our statistical calculations, we assumed that the scores in the two sections were normally and independently distributed. The Standard Deviation of the difference between means was found to be 2.2, and the 95% Confidence Interval for this difference was 4.2 ± 4.3, or from -0.1 to 8.5. By hypothesis testing, we found that the probability of a difference this great or greater happening by chance alone was 0.0574. So we are 94% sure that there is a significant difference in the performance of the two sections.

Could the difference be explained by the preponderance of sophomores in the SRS Section? To test this hypothesis, only sophomores in the two sections were compared. The data are summarized in the following table:

Statistical studies seldom yield unequivocal conclusions. It is true of this small study of ours also. Our findings are not out of line with conclusions of three similar studies previously made by other investigators:

TABLE 2

Showing the Characteristics of only Sophomore Students in the Conventional Section and the SRS Section and Their Final Examination Scores in General Psychology

Measures	Conventional Section	SRS Section	Difference: SRS over or under Conv'l
No. of Sophomores	12	19	+7
SAT-Verbal Scores			
Mean	584	578	-6
S. D.	59	64	+5
SAT-Math Scores			
Mean	529	552	+23
S. D.	63	65	+2
Engl. Comp. Scores			
Mean	566	603	+37
S. D.	57	57	0
Converted Rank in H. S.			
Mean	60	61	+1
S. D.	9	7	-2
Grade-Point-Averages at Skidmore			
Mean	2.66	3.15	+.49
S. D.	.51	.53	+.02
Psy. Final Exam. Scores			
Mean	77.8	82.0	+4.2
S. D.	10	10	0

This time there existed a less than 4% difference in SAT-Math Scores, a difference of about 6% in English Composition Scores, and an 18% difference in Grade-Point-Average, all in favor of the SRS Section. The difference between the means of the two sections in Psychology Final Examination Scores was 4.2, which was exactly the same as the difference between the two total sections. The Standard Deviation of the difference between the means of the two sophomore groups, by the small sample method, was 3.8, and the 95% Confidence Interval was 4.2 ± 7.77, or from -3.57 to 11.97. By hypothesis testing we are less than 75% sure that there is a significant difference in the performance of these two groups of sophomores. The slight superiority of the sophomores in the SRS Section in academic ability as indicated by their somewhat better mean scores in SAT-Math, English Composition, and Grade-Point-Average could at least partially explain some of the found difference between the means of the two groups. But at least the direction of the difference is in favor of the SRS group.

While a difference of 4.2 points between the mean scores of the two sections on the Psychology final examination in favor of the SRS Section was not large, we must bear in mind an inherent limitation of the "equivalent group comparison" technique, namely, a common examination of the multiple-choice type had to be based on largely factual content material taught in common to both sections and ignored any innovative materials and methods used only in the experimental section as well as the more subtle and subjective learnings that could have accompanied the innovative features of the teaching-learning process. If there had been, instead, many small tests on specific topics in the course, designed in such a way as to reveal not only mastery of factual content but also more sophisticated learning outcomes, the difference in the performance of the two sections might have been larger or at least more meaningful, even if not any larger.

(1) Dr. Henry O. Thompson at Syracuse University taught one section of a course in Religion in the traditional way and another section using a much larger amount of visual material to replace some of his lectures and supplement others as well as employing the Student Response System. At the end of the semester it was found:

> "Achievement, as measured by examinations, did not vary significantly between the groups. This finding is not definitive, however, since the final exam was based on the common lecture material and did not attempt to test the outcomes of the enriched experiences of the experimental group."*

(2) Dr. Martha W. Bradley, in teaching a course in Education, used a manual response method to a visual-verbal mode of instruction in one section and the Student Response System in another section. A comparison of student achievement in the two sections led to the conclusion:

> "The difference (in favor of the SRS Section) was significant (at the .01 level of confidence for the quizzes but not significant for the final examination)."†

(3) Dr. William P. Hillgartner compared the effects on student achievement of three treatments in three sections of a course in Teacher Education:

(a) Use of SRS for individual diagnosis plus individualized assignments.

(b) Use of SRS but no individualized assignments.

(c) No use of SRS and no individualized assignments.

He found:

> "The results strongly suggest that the regular incorporation of a response system into a program of instruction tends to raise the level of achievement... When the response system is used to collect feedback upon which individual assignments may be based, the level of achievement tends to rise even higher."‡

XII. SUMMARY OF EVALUATION

A large majority of our faculty users have found the Response System either "moderately" or "Quite" useful, in some cases, "very" useful, for the following purposes:

1. Generating class discussion -- breaking the ice, stimulating thought, preventing degeneration of discussion into a lecture.

2. Collecting information on student opinions, feelings, attitudes, and other subjective aspects pervading the learning process whether in non-science or science courses.

3. Student evaluation of instructional materials--films, slides, readings, research, courses, instructors, etc.

4. Monitoring student acquisition of basic knowledge--facts, concepts, procedures, etc. -- whether gained from individual study or from class instruction.

5. Administering quizzes, tests, examinations whether for grading purposes or not.

6. Monitoring individualized study and analysis of quantitative data entered through the SRS in the Free Mode.

The chief limitation of the System is that it cannot accept constructed answers to open-ended questions. Hence, it cannot monitor the more sophisticated learning outcomes. However, even the most sophisticated learning has to rest on a foundation of basic knowledge of facts and concepts, which can be readily tapped by objective-type questions. If the instructor requires his students to assume greater responsibility for acquiring basic knowledge through individual study, this will free him from going over basic material in lectures and enable him to teach in class only what the students have failed to get themselves and to devote more time to sophisticated and creative teaching apart from the SRS.

Obviously, it is unrealistic to expect any device to work perfectly in all situations. There is no panacea in the complicated task of college teaching. In the personal opinion of the Principal Investigator of this project, the outstanding virtue of the SRS is that it directs the attention of the instructor to student responses. Having associated himself with college teachers for over forty years in three different countries, he believes that many instructors, including himself, when they walk into the classroom, are preoccupied with the material they are going to lecture on. Seldom do they think of student responses to the material unless they intend to tell a joke. Yet psychological researchers have demonstrated that students learn, not directly from instructional materials, but from their own reactions to the teaching. This explains why different students often learn different things from the same material or the same teacher. The instant collection of responses of all students and the speedy analysis of the data by computer make it impossible for the instructor to ignore this evidence. He doesn't wait days, weeks, or even months until he gives a test before he knows what the students have learned. With the evidence before him, he can continue to exploit his strengths, and where improvement is called for, he would probably try other ways of teaching. Thus, he is encouraged continuously to improve his instruction to the point of his own satisfaction. To use a Chinese simile, "The scratch is applied to exactly where it itches."

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*Center for Instructional Communications. Monograph Series, II: Instructional Systems Development. Syracuse University. 1968. Part III, P. 4.

†Ibid, Part III, P. 5. (Italics inserted by the present writer.)

‡Ibid, Part III, P. 6.